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EDGEWOOD ARSENAL
TECHNICAL MEMORANDUM

EATM 300-7

SUMMARY OF PROGRESS
DETECTION & WARNING LABORATORY (U)
FIRST QUARTER FY71

by

Solomon Love
Robert M. Gamson
Harvey Tannenbaum
John C. Young
William Y. Keane
James W. Cauller

December 1970

DEPARTMENT OF THE ARMY
EDGEWOOD ARSENAL
Defense Development and Engineering Laboratories
Detection and Warning Laboratory
Edgewood Arsenal, Maryland 21010

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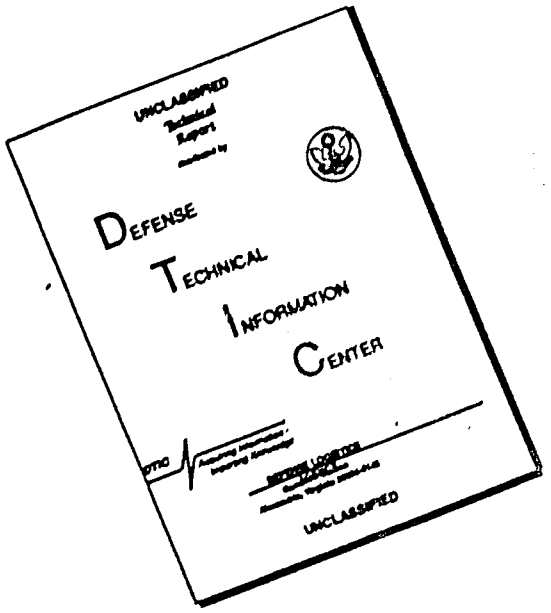

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EDGEWOOD ARSENAL TECHNICAL MEMORANDUM

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DETECTION & WARNING LABORATORY (U)

First Quarter FY71

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Projects 1B662710AD27
1B662710AD29
1B662708AD18
1B663705D601

DEPARTMENT OF THE ARMY
EDGEWOOD ARSENAL

Defense Development & Engineering Laboratories
Detection & Warning Laboratory
Edgewood Arsenal, Maryland 21010

(U)

FOREWORD

This is one of a series of memorandums on the progress of work in The Detection & Warning Laboratory, Defense Development & Engineering Laboratories. These reports are prepared in connection with internal reviews and analyses, which are scheduled every three or four months. They cover work accomplished under projects listed on the title page and are of a continuing nature. They are made available to the distribution shown on the last pages of this report. It is hoped that they will provide a reasonably current account of research and development in the defense field.

This memorandum is issued for temporary or limited use only, and it may be superseded. It may not be distributed outside Edgewood Arsenal installation without prior approval of the Commanding Officer or the Technical Director, Edgewood Arsenal.

(U) TABLE OF CONTENTS

TECHNICAL REPORTS

The following reports were published during the report period:

EATM 300-5 Summary of Progress Detection & Warning Laboratory, 4QFY70.

CONTRACT REPORTS

Block Engineering, Inc. (Remote Raman Detection Studies)	DAAA15-69-C-0328	Fourth Quarterly Progress Report Nov 69 - Jan 70 (Received Nov 70)
Block Engineering, Inc. (Remote Raman Detection Study Instrument)	DAAA15-70-C-0418	First Quarterly Progress Report Jul - Sep 70
General Electric Co. (Isotopic CO_2 Laser Study)	DAAA15-69-C-0528	Final Report Aug 70
IIT Research Institute (DC Discharge Detector)	DAAA15-69-C-0636	Final Report Jul 70
Midwest Research Institute (Electrochemical Enzyme Alarm)	DAAA15-70-C-0166	Quarterly Progress Report Jun 70
North American Rockwell Autonetics Division (Cml Lab Equip & Procedures for Field Use)	DAAA15-70-C-0065	Third Quarterly Progress Report Aug 80
Southern Research Institute (Agt Conc Devices for Use with C-Agt Alarms)	DAAA15-70-C-0247	Second Quarterly Progress Report Nov 70
Westinghouse Electric Corp. (Dev of Multipurpose Cml Agt Detector Kit)	DAAA15-68-C-0675	Sixth Quarterly Progress Report Feb 70 (Received Oct 70)

I. (U) Engineering Development

A. M8 Chemical Agent Alarm

Support Studies - Project 1B662710AD27-01

1. M8 Electrochemical Cell

Detection and Warning Laboratory personnel have completed the training and technical supervision to the Edgewood Arsenal production activity to assure the competence required to fabricate the 450 electrochemical cells which are to be supplied as GFE to the contractor. Liaison efforts have continued through the 50 Pre-production cells which are nearing completion and will be tested in accordance with the applicable Purchase Description.

Detection and Warning Laboratory personnel have fabricated 50 electrochemical cells incorporating Englehard electrodes, which are undergoing high temperature, field interference, storage at extreme temperatures, vibration and shock tests and agent sensitivity checks to verify the adequacy of design. It is planned that this test program shall be completed by 1 December 1970 and recommendations to implement this design into the production program will be made if results prove satisfactory.

These laboratories have ordered and are to receive in 2QFY71 an ultra-sonic welder which shall be used in perfecting assembly and fabrication techniques of the ultra-sonically welded cell. It is felt that this technique of assembly will eliminate the necessity of extreme care now employed in gluing the present cell thereby reducing and/or eliminating leakage problems. A major reduction in assembly and fabrication time during production would be realized. Preliminary design reviews have been held with DuPont and Branson Sonic Welding and various engineering design changes have been recommended. Evaluation of the ultra-sonically welded cell will be conducted upon verifying the assembly and fabrication techniques which will ultimately lead to acceptance for future production.

Personnel from these laboratories conducted limited evaluation tests on the redesigned electrochemical cell scrubber. It was found that at high temperature, erratic operation is experienced. It appears that a contributing factor to this erratic operation is the packing of the silver in the flexible tube and the method of attachment of the tube to the cell housing.

2. Pump Motors

Multiple source pump motors for the M8 Detector pump module are still under evaluation. A quantity of these motors have been subjected to over 4000 hours of operation and are scheduled to be tested for high and low temperature storage and vibration and shock to verify

adequacy of design.

3. Detector Case Bottom

In-house testing of the detector case bottom has been completed. Under low temperature impact tests cracks developed on the case bottoms. Discussion with the material vendor indicate that the cracks can be attributed to improper molding techniques. In our opinion the poly-carbonate material used in the design of the case bottom is adequate to meet the design requirements. Current plans are to fabricate (in-house) additional case bottoms and perform evaluation tests to verify the adequacy of design.

4. Simulant Program

Studies have been initiated to develop simulant compounds which could be used in lieu of agents GA, GB, and VX in testing M8 alarm systems, including the acceptance tests of future production contractors. Currently these three agents are used to evaluate both the sub-systems on an individual basis and the entire alarm system as a completed entity.

Benzene sulfonyl chloride (BSC) is being studied as a substitute for GB since it is now used on non-quantitative basis to monitor detector performance after original check out on agents. Response times to the simulant have been considerably longer than those to equal concentrations of the agent, but more important, they have been very erratic. For instance, a response time of .50 min. was obtained from BSC concentrations of 1.50 γ/l, 0.67 γ/l, and 1.19 γ/l. Testing will continue with BSC and other simulant candidates.

A literature search for candidate VX simulants has been conducted and a number of compounds, mainly insecticides of V-like structure, have been ordered or are being synthesized in-house. Based on discussions with Research Labs personnel, we are synthesizing a number of phosphonothiolates which would be relatively non-toxic yet retain the V-like structure. Laboratory tests to quantify M8 alarm responses and to determine the effectiveness of simulants in evaluating the VX conversion prefilter are being initiated.

B. Detector Kit, Chemical Agent, Multipurpose, XM235 and Detector Kit, Chemical Agent, VGH Vapor, XM181

The engineering development of both the XM235 and XM181 have been suspended and the designators XM235 and XM181 retired. The details of current exploratory development work on items which will provide significant improvements over both the XM235 and XM181 are reported under Sec. III, D. An advanced development project is being set up for this work.

II. (U) Advanced Development

C-Agent Detection System for Vehicles, Vans and Shelters. Task 1B663705D601-02

A. In-House Effort

In July Bendix Environmental Science Division delivered to Edgewood Arsenal two basically different configurations of combat vehicle alarms systems for system testing. One system contains an air inlet, single disc prefilter, SE 30 agent concentrator and M8 detector. The other, a flow through system, contains an air inlet, cassette filter changer, a Porapak column and the M8 detector. Both systems have been subjected to agent tests and specific thermal problems have been encountered at low temperatures (-40°). It was found that the prefilter changers cannot maintain elevated temperatures when exposed to low ambient temperatures. Both prefilter changers were returned to Bendix and re-engineered to incorporate additional insulation. The modified prefilter changers have been recently returned to Edgewood Arsenal and system testing initiated. Preliminary agent tests have revealed agent hold-up which appears to be significant. Efforts are being directed to the definition and resolution of the problem.

The agent concentration chromatographic tubes for use with C-agent alarms continue to show considerable potential. Tubes packed with 10-12 mg. of Porapak N porous polymer beads appear to give the best trade-off between adequate slippage of higher concentrations of GA agent and ability to concentrate the low concentrations of VX conversion product. (Slippage is more pronounced with higher volatile compounds.)

Alternate designs being studied include a split column where 50% of incoming air would be delivered directly to the cell and the remaining portion would go through the packing material of the column. Preliminary data indicate it may be possible, with different amounts of packing material, to improve upon response times of the higher concentrations while also improving upon concentration and detection of lower agent concentrations. These studies will continue.

B. Work under Contract DAAA15-69-C-0164 (Bendix)

Due to technical difficulties experienced during prototype system testing, i.e., thermal problems and agent hold-up, engineering changes to system components have been made. It was originally planned to complete Phase I which included system testing in June of 1970; however, due to the modifications required, Phase I which included system testing will be extended to 30 October 1970. Due to problems in this Advanced Development Program, it is planned to extend the completion date of the contract from April 1971 to July 1971. Because of limited funds, a contract modification will include a reduction in the quantity of hardware delivered to the

government and reduction in efforts for documentation; i.e., manuals, specifications and reliability and maintainability tasks. This contract modification will permit the Advanced Development program to be completed, providing meaningful hardware and documentation for a Concept Formulation Report which will determine whether the work performed meets the prerequisites for entering into the follow-on Engineering Development programs.

The subject contract, which is negotiated to be $1,228,750, has been incrementally funded for a total of $933,000. An additional $150,000 was forwarded for further incremental funding. It is estimated that this amount will cover the performance of the advanced development contract through January 1971.

A Periodic Development Review (PDR) of the Advanced Development program is scheduled to be held at Edgewood Arsenal on 23 November 1970.

Bendix Environmental Science Division, contractor for the CVA effort, has been supporting the system testing being conducted at Edgewood Arsenal and providing engineering modifications to system components as the need arises.

III. (C) Exploratory Development

A. (C) Automatic Alarms for Incapacitating Agents (1B662710AD27-01)

M8 with Pyrolyzer

Studies with this system continue to concentrate on reducing the detrimental effect of airborne contaminants on detector performance. Evaluations of such devices as silver nitrate impregnated charcoal columns and a cyclically heated fiber filter to take advantage of thermal stability differences between contaminants and agent particles have only been partially effective. An additional approach being studied is a dual inlet-dual cell arrangement where responses to contaminants would be approximately equal and therefore could be nullified. A combination of this approach and the in-line filters which have shown some success will be investigated. Efforts in this area are being greatly curtailed because of work on higher priority programs.

B. (U) Passive LOPAIR

Task 1B662710AD27-02	Priority	Proposed Schedule		
		AD	ED	TC
	I	72	74	77

1. Field Measurements

Technical work on Contract DAAA15-68-C-0476, Area Scanning Spectral Modulation Studies, with the Bendix Corporation has been completed. The contract will be closed out when the final report is delivered. The purpose of this contract was to design and build a computer controlled spectrometer for use in background and air-path infrared measurements and as an alarm simulator for proof of Passive LOPAIR techniques. As a result of this contract we have a versatile system which has been used on many field tests and has provided much useful data on background. Various field measurements have been made at Edgewood Arsenal, Ann Arbor, MI, Naval Weapons Lab, Dahlgren, VA, Army Ammo Plant, Baraboo, WI, and Fort Benning, GA. Results of these tests have been processed and have yielded design data for evaluation in C-agent detection systems which are currently being developed. Based upon this work, there is a good chance of success for a Passive LOPAIR system using no more than six wavelengths and simple electronics when used with a sky background. This is the basis for a D & F request for a feasibility study contract to be negotiated in FY 71.

A field test was performed at Badger Army Ammo Plant, Baraboo, WI, in August 1970 to determine the applicability of Passive LOPAIR techniques to air pollution problems. Known pollutants at this test site were NO_2, SO_2, NO_x (a mixture of nitrogen oxides), particulates and sulfuric acid mist. Although this test was a first attempt to determine these compounds, NO_2 was definitely identified and SO_2 absorption peaks were thought to be present but results were inconclusive. Sulfuric acid mist was not identified because the plant producing it was not in operation during the tests. Particulate effluents appeared as a blackbody radiator which obscured the SO_2 which was known to be present.

Quantitative estimates of the pollutants were not possible because of the large number of variables which could not be measured with the present equipment. Consideration of the problem indicates that useful instrumentation can probably be devised using single-beam infrared spectroscopy techniques, although many questions are yet to be answered before predictions of the performance of such a system can be made. Since the problem is not only one of detection, as is the case with LOPAIR, but one of quantitative analysis, the techniques will be different and will bear further investigation. These investigations will be carried out as a part of our Passive LOPAIR field measurements program.

2. Instrumentation Evaluation

Two new instrumentations have been acquired for installation in our field test van. A Block Engineering Model FTS-14 Interferometer Spectrometer capable of excellent spectral measurements of backgrounds and air paths was used in the Badger tests. This system has a spectral resolution of two wavenumbers and produces either direct single-beam spectra or spectra referenced to a stored spectrum as an X-Y plot. Effort is being made to produce the data in digital form for automatic data processing such as that which is used on data from the Bendix system.

An Exo-Tech field model ten channel spectrometer has been acquired. This is an improved version of the Navy Advanced Development prototype. This system can be adjusted to simulate an actual LOPAIR alarm with up to nine active channels, plus one air temperature reference channel, for any parts of the spectrum between 7 and 14 microns. Electronic circuitry is available via a patchboard to reproduce the linear alarm equations that have proven satisfactory in Passive LOPAIR applications. When set up to simulate an actual agent alarm system the performance is directly relatable to an field engineered system. Real alarm parameters are being evaluated with this system.

Our Passive LOPAIR Van is now equipped to perform the critical measurements to verify the desired field performance, update spectral modulation schemes and compare the most likely instrumentation techniques. It is anticipated that, by the time the D & F request has been processed, enough data will have been accumulated to permit valid instrumentation parameters to be selected.

The Passive LOPAIR System Engineering Management Plan is being drafted. There is, however, a lack of knowledgeable guidance, and much time and effort is being devoted to evolving an acceptable document.

3. IR Spectral Studies

All spectral data on magnetic tape have been sorted. This includes agent, interference, and dust data. Some corrections still have to be made, but the data are in good condition.

The contract with Southern Research Institute for additional infrared spectral studies of the agents has been signed. During the first phase, they will determine the most effective way of making the measurements.

C. (C) Advanced Field Warning System

Task 1B662710AD27-01	Priority	Proposed Schedule		
		AD	ED	TC
	I	75	78	82

1. (U) Automatic Liquid Agent Detection

a. Conductivity Approach

Studies on the Conductivity ALAD approach continue to show promise although some problems areas remain to be resolved. Testing at Edgewood Arsenal during this reporting period indicated an interfering effect with HC smoke which decreases sensitivity, precluding a satisfactory detection capability. Operating in the scavenging mode at approximately 2,000 rmp, the detector elements quickly decreased in resistance in the presence of dense clouds of HC and indicated no response to simulant at the conclusion of each. The nature of this phenomenon is currently under study, but as yet the actual source of the interference is not known. It was also observed that the red, green violet, and yellow smokes caused downward shifts in detector resistance, although the magnitude of the change was not as great as in the case of HC and agent detection did not seem impaired. As in the case of the FMIR system, the conductivity ALAD responded to Parathion. Other interferences, including napalm smoke and vapors of ble ach , did not affect the instrument.

Meanwhile, further study on the rain-water interference problem was continued. The contractor, Litton Systems (DAAA15-68-C-0600), found that by substituting ethylene glycol monoethyl ether (EGME) in place of methyl ethyl ketone (MEK) in the conductivity formulation, abrasion resistance and freedom from rain-water interference was significantly improved. It was felt that these improvements were due to "leafing" of the silver in the resin, a condition wherein the silver flake tends to come to the surface of the resin due to a more slowly drying solvent. It is known that leafing results in a more durable, hence abrasion resistant surface. It was also Litton's conclusion that EGME-prepared-detector elements were further improved by a final treatment with acetone which resulted in a more highly conducting grid. At first it was not known why acetone resulted in lower resistance; however, it was recalled that the silver flake as purchased is coated with stearic acid. Normally, the stearic acid is dissolved in MEK but EGME is not as good a solvent for this purpose. Thus, treatment with acetone simply makes the elements more conductive by removing the stearic acid.

Contractor prepared detector elements were tested at Edgewood Arsenal for operation in a simulated rain environment. The rotating scavenger unit was operated at 2,000 rpm. and a garden hose was utilized to produce a "fine" and "coarse" spray. The falling water droplets contained velocity components along both the vertical and horizontal, simulating a wind-driven rain. However, the trajectory of the spray from the hose was kept high enough to preclude too high a horizontal (i.e., wind) component due to water pressure. The results were significant in that the EGME elements with or without acetone treatment were much more stable than the MEK prepared grids.

The latter were, in some cases, unable to remain conductive in the presence of light spraying. All of the EGME elements remained conductive during the light spray and only a few actually opened up under coarse spray conditions. The improvement noted was dramatic even though the problem is yet to be resolved to the necessary degree.

Cornell Aeronautical Laboratories (DAAA15-69-C-0655) has been investigating the surface energy considerations of the conductivity elements, as well as similar considerations relating to the LAD badges. Samples of the conductivity elements and LAD badges have been sent to Cornell for evaluation and treatment by either a glow discharge apparatus and/or the application of surface chemical coupling agents to permanently effect the desired surface properties of the detectors. Results of these studies are still pending.

After having essentially completed the evaluations of the competing approaches to ALAD, it appears that the conductivity method has significant advantages to offer over its FMIR and photometric competition. They may be summarized as follows:

(1) Sensitivity: As a droplet scavenger, conductivity has demonstrated detection Ct's as low as 0.02 gamma-minutes/liter for 50-micron droplets with average detection times of less than 1 minute.

(2) Simplicity: Although it appears that droplet scavenging is required to achieve high sensitivity, the conductivity approach remains the least sophisticated ALAD technique known. In the static mode it could become a simple add-on attachment to the M8. In its dynamic, high sensitivity mode, the instrumentation required would still be minimal.

(3) Universality: Conductivity ALAD will detect liquid V, G and H agents.

(4) Cost: Because of its inherent simplicity, further study and possible development of a conductivity ALAD alarm, even as a droplet scavenger, would be the least expensive approach.

It should be noted that problem areas remain to be solved (see above). However, it is presently felt that the solutions are within the current state-of-the-art. Furthermore, as an in-house back-up approach, investigations of the photometric technique will continue. This method is preferred over the FMIR as a back-up for the following reasons:

(1) Further effort on the FMIR approach would not be as fruitful because of the more advanced study of this technique. The operating parameters of the FMIR system are fairly well known; those of a photometric system still require definition.

(2) The photometric approach utilizes already developed detection formulations containing the B1 dye. Since this is the most critical element in such a system, it is extremely valuable to know all relevant parameters.

(3) Photometric instrumentation will cost significantly less than the FMIR because optical components for use in the visible portion of the spectrum are considerably less expensive than those for the far infrared. In addition, uncooled detectors with orders of magnitude more sensitivity and good time constants are readily available.

(4) Simple instrumentation concepts utilized in the conductivity approach are more easily adaptable to photometric than to FMIR. For example, the droplet scavenger collector has already been adapted to the photometric approach.

b. Photometric ALAD

This is an in-house low level-of-effort backup to the conductivity approach. Much of the instrumentation and test technology is applicable to both techniques.

Initial efforts are being devoted to assembling a laboratory breadboard instrument for basic measurements. It is felt that the internal reflection technique (FMIR) applied to the visible region may significantly enhance sensitivity, and spectral measurements on the dyes are being made.

Glass hemicylinders were cut and polished and the 972 b paint was applied to the hemicylinder backs. The undissolved paint absorbed well over 50% of the incident radiation. More exact spectral measurements will be made in the near future.

Additional measurements were made of the dissolved paint in the solvent Tri-(2-Ethylhexyl)-Phosphate (simulant for VX). The absorptivity coefficient and peak location were very similar to those determined for the dye in methyl alcohol.

c. FMIR Approach

The in-house evaluation of the fieldable FMIR system has been essentially completed with the possible exception of some confirmatory follow-up testing. In response to the water and dust interferences, three techniques have been studied to minimize or eliminate the problem: (1) changing the reference wavelength on the filter wheel to minimize both water and dust signals; (2) investigation of special surface chemical coatings which preclude intimate dust contact with the FMIR radiation field; and (3) the addition of an air sampling system to minimize the more troublesome dust particles of lower size (i.e., less than 20μ).

Dr. N. J. Harrick, consultant to Def Dev & Engr Labs on the FMIR program, in a meeting at Edgewood Arsenal, pointed out that the shifting of the reference wavelength from 8.95 to 9.25 microns would halve the interfering signal magnitude from water without affecting agent sensitivity. Although liquid water would still remain a potential problem, the absorption coefficient relative to the two wavelengths would be quite small. It is possible that the collection of sufficient quantities of water on the cell to cause interference problems could be minimized by vertical orientation of the cell.

Cornell Aeronautical Laboratory (Contract DAAA15-69-C-0655) has been investigating possible surface chemical solutions to the dust problem. One very promising approach consists in the application of a unique 5-micron thick webbed film of coated polypropylene fibers. This fiber is non-absorbing in the spectral region of interest Laboratory testing with dust, simulant malathion, and dust-plus-water have confirmed the credibility of this technique for precluding the detection of interfering dust. The "KEY" to this approach is the porosity of the polypropylene fibers, permitting liquids to be drawn toward the germanium cell by capillary action but essentially trapping particulate matter safely away from the radiation field. Although initial success has been achieved with this approach, it remains important to follow-up with studies aimed at enhancing the liquid wetting by properly "adjusting" the surface energy of the fiber mesh. This is possible because of the availability of several types of polypropylene fibers of differing surface tension. It should be noted that this technique is also being used to study enhanced spreading and increased abrasion resistance on liquid agent detector papers or conductivity elements.

The contract with Block Engineering (DAAA15-69-C-0293) is nearing completion with the just delivered air-sampling attachment for the FMIR instrument. Block will be sending the air-sampling pump in the near future, hopefully in time for the next series of interference tests to be conducted in October at Edgewood Arsenal.

Interference testing at Maxwell Point was conducted in late July and early August 1970, with the FMIR system (without sampling) successfully undergoing tests with colored smokes (violet, red, green, yellow), HC smoke and bleach. Parathion, as expected, caused an alarm response. Parathion is occasionally used as a liquid agent simulant for the FMIR.

Data gathered in the in-house evaluation of the FMIR instrument indicate the capability to detect a single 50-micron droplet of VX with a 5:1 signal-to-noise ratio. It has also been established that the dust interference can be eliminated by the use of powder coatings or the more desirable surface chemical fiber meshes. Furthermore, the coupling agent Nylon-4, when coated upon an FMIR cell, provides the necessary surface tension to promote agent droplet spreading without surface energy degradation over long periods of time or with exposure to the elements. Finally, it appears that the FMIR approach might be reliably used to monitor clothing or other materials for the presence of liquid toxic agent contamination. Although no sensitivity limit has been defined, the present instrument has indicated the presence of 1.0 microliter of simulant after 1.5 hours time on ordinary fatigue cloth. In short, the FMIR instrumentation is relatively close to the present state-of-the-art to be expected in tactical field instrumentation and possesses adequate sensitivity and specificity. However, the cost of further research and development on this approach appears unwise at this time in view of the very promising conductivity technique and the less costly but yet unproven photometric method.

2. (C) Laser Applications

a. (U) Remote Raman Detection Study

Negotiations on the final funding of Contract DAAA15-69-C-0328 have been accomplished and the draft copies of the Final Comprehensive Report have been received for editorial review and technical evaluation. This study program, which has engendered so much outside interest (MERDC, AFSC, Dept of HEW, BRL, Vandenberg AFB, W-P AFB, US Customs Bureau, and others) has provided the technical basis for the present effort in the Remote Raman Detection Instrument contract with Block Engineering, Inc.

b. (U) Remote Raman Detection Instrument

Block Engineering, Inc., (Contract DAAA15-70-C-0418) has completed the assembly of the signal-processing electronics and has fully tested the circuit boards, power supplies, cabling, photo-multiplier detector and multi-channel recorder. Most of the in-house fabrication of the optics mount and base has been completed. With delivery of the laser system from Spacerays, Inc., at the end of September (one month earlier than originally scheduled), the assembly of the laser and its power supply and external optics will be completed and tested. The contract modification to allow the contractor to specify and purchase the primary collecting optic (telescope) for the system has been executed. The scheduled delivery of the 36-inch mirror system is anticipated by December--possibly November. The necessity for the procurement of the mirror rather than application of the GFE five-foot searchlight mirror was uncovered as a result of the optical testing of the GFE mirror. The optical parameters of the searchlight mirror were so inferior that it would be impossible to obtain minimum required performance of the Remote Raman Detection Instrument. The additional cost of the design and fabrication of the 36-inch telescope system is approximately $59,000. In addition, a request has been submitted to Dir of P&P to modify the work scope further to provide the system with integral power so that adequate field testing can be accomplished at sites remote from "House Power" and so that the system need not rely on rarely adequate line voltage power sources. The present requirement for nearly 85 KW (although for short time periods) would put a severe strain on all but the most generously endowed potential powered sites, including the sites around Edgewood Arsenal. The major contributor to the extremely large power requirement is the poor power factor associated with the power supply for the pulsed laser. Significant improvement--perhaps 75%--could be made by proper power supply design to which some consideration should and is presently being given.

Interest exhibited by various groups, including those mentioned under the description of the previous contract effort, involves the remote detection of such materials as explosive vapors both prior to and after detonation, vehicle exhausts, vehicle parks (from vapors associated with fuels, oils, etc.), POL storage areas, airborne materials associated with human activities (vapors and/or aerosols), marijuana, and various air pollutants. Close cooperation with the interested agencies has been promised and, where not too much additional effort need be expended, we have offered to add their sample materials to our list for both laboratory Raman Spectroscopy and field evaluation with the Remote Raman Detection Instrument. Offers of funding support

have been proffered on condition that additional expenses are necessarily incurred due to material, time, and personnel requirements.

c. (U) Isotopic CO_2 Laser Study

The draft of the Comprehensive Final Report (Contract DAAA15-69-C-0528) has been received for editorial review and technical comment and returned to General Electric for printing. Although the contract technical work scope had been completed early in the calendar year, a delay was incurred in the initiation of the life-testing due to the inability to obtain machine shop services during the strike. A no-cost time extension to the contract was executed in order to delay the final report submission until data could be included relative to the life-testing and field test procedures. The draft report thus provides field test information for the two-mile Cazenovia, NY, test site and preliminary life-test data. Life testing will continue for several additional months under company sponsorship, and the contract technical personnel have promised to make all the data available to Defense Development & Engineering Laboratories when their in-house work is published.

d. (U) Laser Measurements Program

Unfortunately, and once again, the special 9.6-micron CO_2 laser exhibited unacceptable operation after having other deficiencies corrected by the contractor, Sylvania, and shipped back to Defense Development & Engineering Laboratories. Laser output was erratic and unstable, varying plus and minus 50% (long term) as compared to the required specification of less than 5% total. Once more the unit was returned to Sylvania for repair. Discussions with Sylvania personnel have indicated that the prime cause of instability was the chance near-perfect alignment of the germanium output window with the plasma tube axis, causing the window to act as an etalon in resonance with the actual output etalon of the laser and varying with the temperature gradients generated at the front of the unit. An optical wedge was used to correct this problem. Additional instability has been found to exist in the high-voltage power supply due to poor design. This module tends to draw excess current from a highly regulated excitation power supply when the plasma-tube current exceeds 9mA and the regulation of the smaller supply suffers. This problem is common to all Sylvania lasers of this type, regardless of output wavelength. A field modification is being tested for future retrofit. In the interim, the laser will be operated at a discharge current of 9mA. In addition, there may be slow leaks in the SF_6 chamber at the rear of the laser between the Brewster window and back mirror. This normally fixed mirror has just been replaced with an adjustable unit and it is felt that the SF_6 may be escaping at this juncture. Sylvania personnel are in touch with

Defense Development & Engineering Laboratories from time to time, updating the progress of efforts to correct the deficiencies in this laser. Although all of these deficiencies are being corrected at Sylvania's expense, these problems have precluded any useful work in this important area. It has been decided that if more trouble is experienced with the 9.6_{μ} laser, no further attempts will be made at repairing the unit. Sylvania will most probably be asked to supply a standard 10.6_{μ} off-the-shelf laser unit and the special 9.6-micron model will be declared "unacceptable."

The safety interlock system for operation of the laser equipment in Bldg 3330, Room 271, was installed during this reporting period.

e. (U) Computer Signal Processing Study

At the present time, consideration has been narrowed to the top four bidders on the basis of technical scores. All four cost proposals are within or very near the Government estimate of costs and labor. A request for additional information has been sent to three of the bidders for more detail on how they would evaluate the state-of-the-art in laser technology relative to their application to automatic C-agent detection and alarms. Technical evaluation of the additional information should then provide a justification for the selection of a single bidder for contract negotiation. Award is anticipated early in October.

f. (C) Remote Raman - Laboratory Studies

(U) The expanded-scale spectra of the agents VX, GB, and GD were obtained. The area under the spectral bands were measured using a K&E No. 62-0015 Compensating Polar Planimeter. The agent band areas were then related to the areas measured for the 992 cm^{-1} band of benzene. Using charts supplied by the contractor, the differences in the spectra caused by a different photomultiplier voltage and a different detector quantum efficiency were corrected. The transmission of the monochromator was assumed to be constant over the short region examined.

(U) A comparison of agent band areas with the benzene 992 cm^{-1} band provides an indication of relative scattering intensities. Effort is now underway to relate these areas to a benzene differential scattering cross-section. This will account for differences in spectral bandwidth which the area values do not. This information is necessary for calculating the sensitivities of detection.

(U) The band areas of the agents and their reference benzene area are listed below:

GB

Raman Shift Frequency $\Delta\nu$ (cm^{-1})	Band Area (cm^2)	Benzene Band Area (cm^2) @ (992 cm^{-1})
726	20.1	6.5
780	2.5	

GD

Raman Shift Frequency $\Delta\nu$ (cm^{-1})	Band Area cm^2	Benzene Band Area (cm^2) @ 992 cm^{-1}
731	19.1	
754	53.7	316 cm^2
937	12.1	

(C) VX

Raman Shift Frequency $\Delta\nu$ (cm^{-1})	Band Area cm^2	Benzene Band Area (cm^2) @ 992 cm^{-1}
230	67.6	2000 cm^2
296	90.2	
342	11.1	
463	33.4	
486 & 501	40.0	
529	40.5	
657	30.4	
696	28.4	
745 & 771	134.9	

(U) Future effort will involve trying to check the data reliability. There exists some question as to the cause for the large difference of areas for GB and GD. An even greater difference exists between GB, GD, and VX. The future work will be with diluting the agent with a non-polar solvent in an attempt to eliminate intermolecular effects and possibly self-absorption of the emitted radiation.

(U) An extensive literature search has been undertaken to provide information about atmospheric transmission in the ultraviolet-visible region of the spectrum. The majority of the articles had to be ordered. Several articles have been reviewed and one by W. A. Baum and L. Dunkelman is particularly interesting. Their data were taken in the near ultraviolet for

the calculation of atmospheric attenuation coefficients. The data were taken under a number of atmospheric conditions. These data have been used to calculate the fraction of light transmitted through the atmosphere as a function of distance traveled for the doubled ruby wavelength of 3472Å. A table of average values is given below:

Distance (km.)	% Trans.
0.2	85
0.4	73
0.6	62
0.8	53
1.0	44
1.2	38
1.4	33
1.6	28
1.8	23
2.0	20

These agree reasonably well with those values used in our original sensitivity projections.

3. (C) Enzyme Alarm System

(U) Work on the immobilization of cholinesterase enzyme by chemical attachment to a polymer matrix continues to be the major effort at Midwest Research Institute (MRI) under Contract DAAA15-70-C-0166. Having successfully demonstrated that cholinesterase can be covalently bonded to granular cellulose, studies have been concentrated on the more difficult task of chemically attaching enzyme to cellulose foam, which being a regenerated product is chemically more labile than most other forms of cellulose. To date, after many attempts, a reproducible cellulose foam-enzyme product has been achieved through the reaction of PBO (a dichloro-S-triazinyl dyestuff) with DEAE (diethylaminoethyl) cellulose and cholinesterase. Unlike the earlier results obtained, this product is both homogenous with respect to enzyme activity and is reproducible. However, although pads cut from this foam product have successfully undergone 12 hours of alarm operation, their enzyme activity (0.3 unit/gram) is too low to be totally satisfactory. Previous tests have shown that during alarm operation there is still some activity loss with the chemical immobilized enzyme although at a much lower rate than occurs with physically entrapped enzyme (starch immobilized). Therefore, it is felt that in order to have an adequare safety factor for 12 hours of alarm operation, the cellulose-enzyme pads should have approximately 1 unit of activity per gram and all efforts are now being made to increase the enzyme bonding capacity of this PBO-DEAE cellulose foam product.

(U) In studies using polyrethane foam as the polymer matrix, bromination of urethanefoam has been achieved. It was hoped that this product would form a covalent bond with the amino groups of cholinesterase. However, after reaction with cholinesterase, a product yielding only 0.017 units of activity per gram was obtained. Nevertheless, the bromination of the urethane is encouraging as it gives hope that it can be attached to a coupling agent such as DEAE cellulose which can then attach sufficient enzyme to yield a useful product.

(U) The fabrication of another fieldable study model enzyme alarm (FSA-2) has been completed at Midwest Research Institute and it is now undergoing operational testing.

(U) In-house efforts to chemically bond enzyme to cellulose foam and to absorbent cotton by utilization of carboxyl groups continues. To date, carboxyl groups have been attached to both foamed cellulose and absorbent cotton without visibly affecting their phsyical structures. However, repeated attempts to directly attach cholinesterase to these carboxyl groups by forming activated esters with Woodward's reagent K (N-ethyl-5-phenylis-oxazolium-3-sulfonate) have not been successful and this approach was dropped after discussion with Dr. Harry Brown, an enzymologist, who authored a paper on this method. Efforts are now being concentrated on attaching cholinesterase through a coupling agent (1,3-dinitro-5-fluoroaniline), which attaches to the carboxyl groups of the cellulose.

(C) All hardware for two in-house fieldable study model enzyme alarms has been fabricated and final assembly is nearing completion. In recent GB agent tests performed in the test chamber at the Medical Research Laboratory, the alarm response times of the Def Dev & Engr Labs fieldable study model averaged 2.5 minutes for a concentration of 0.01 mmg/l and 5 minutes for a 0.005 mmg/l.

4. (U) DC Discharge

Due to its relatively low priority and shortage of personnel, no additional effort has been devoted to this technique. Its potential as a field alarm is not considered high.

5. (U) Air Force Multi-Agent Detector System (MADS) (Ion Mobility)

The Air Force engineering development contract with Honeywell is now half completed in terms of scheduled time (at the conclusion of 1QFY71). All drawings are complete and have been released for fabrication. Delivery of the first hardware (12 sensor units) for testing is still planned for 2QFY71 although the program is approximately one month behind schedule. Honeywell attributes the slippage, in part, to a decision to conduct additional sensor studies to yield improved interference rejection and to delays experienced in drawing preparation.

The three sensor units being purchased by Def Dev & Engr Labs, under separate contract, will be identical to the Air Force units and delivered concurrently.

The Gas Plasma Chromatograph similar to the above concept, but with the potential for greater sensitivity and specificity, is being considered for further study. An unsolicited proposal has been received and favorably evaluated, and a small contract effort is planned for this fiscal year.

6. (U) Field Interferences

A contract for the study of battlefield interferences as they affect the performance of agent detection systems was signed with Southern Research Institute. This effort supports all detection systems and the initial study will concentrate on the automatic enzyme alarm and manual devices such as kits and tubes. Southern Research Institute is currently setting up a breadboard enzymatic device and will be initiating laboratory tests with the contaminants.

D. (U) Detector Kit, Chemical Agent, Multipurpose and Detector Kit, Chemical Agent, VGH

Task 1B662710AD29-02	Priority	Proposed Schedule AD	ED	TC
	III	71	73	76

1. General

Subsequent to the decision to suspend engineering development on the XM235 and XM181 Detector Kits, Project 1B664718D022, Tasks 01 and 10, an Advanced Development Plan was prepared detailing a two year AD study of alternate design configurations. Work to be accomplished includes supporting exploratory development studies on component optimization and a search for new kit concepts. Although the ADP has been generally endorsed by both USAMUCOM and USAMC, funding has been delayed largely because of the low priority, Priority III, designated for the kit requirement. USAMUCOM directed that a Special Review be held to obtain a coordinated developer/user/Department of Defense position on the following issues:

a. Reaffirmation of the requirement.

b. Priority of the requirement.

c. Approval of the development approach contained in the ADP.

A USAMC Pre-IPR was convened on 2 Sep and the following USAMC position was established for the formal IPR to be held on 28 Oct:

a. The requirement remains valid for the development of a multipurpose chemical agent detector kit and a simplified VGH detector kit to replace the AN-M2 Water Testing and Screening Kit, ABC-M3 Food Testing and Screening Kit, M4A1 Water Testing Kit, Poisons, M30A1 Refill Kit, M18A2 Chemical Agent Detector Kit, and the M15A2 Chemical Agent Detector Kit, VGH. In view of the unsuccessful engineering development effort to date, and the resultant requirement for further evaluation of alternate design configurations, it is recommended that an Advanced Development Objective (ADO) be established to support the necessary advanced development effort. Although the requirements specified in the revised QMR, approved Aug 68, and the existing Technical Characteristics are still generally applicable, an ADO would provide the opportunity to better define the requirements and consider potential design trade-offs to upgrade the capability.

b. It is recommended that the priority of the requirement be upgraded from Priority III to Priority I for the following reasons:

(1) The requirement reflects capabilities essential to the chemical defense posture. Existing standard kits cannot satisfy all requirements. The new kit requirements for simultaneous sampling for all agents and for simplicity of operation exceed the capabilities of the existing kits to such an extent as to fully justify definition as a new capability

rather than a replacement capability. Specific inadequacies of the existing kits are:

(a) The complex manipulation and mixing of chemicals required in the operation of standard kits are impractical for the field soldier wearing protective clothing. (None of the standard kits were subjected to USATECOM type service testing to assess usability prior to type classification.)

(b) The sequential sampling for each agent required by standard kits is too time consuming for field operations (approx. 20 min.) and could result in the failure to make a detection of a specific agent involved in a non-persistent agent attack due to downwind travel of the cloud before sampling was accomplished.

(c) The AN-M2 Water Testing and Screening Kit does not provide any test for hydrogen cyanide (AC) in water.

(d) In Final Report on Check Test of Water Pretreatment Decontamination Set, CB Agent, Nov 68, USATECOM concluded that the AN-M2 Water Testing and Screening Kit "could not determine the potability of treated water originally contaminated with L (lewiste) and/or HD (mustard)." (USATECOM Project No. 7-3-0311-07, DTC Project No. R-E842).

(2) In addition to conventional kit use concepts for determining when it is safe to remove protective masks and for the detection of hazardous contamination of water and surfaces, these kits will supplement the early warning capability for V and G agents at concentrations below the threshold of the M8 Alarm and also extend the detection capability to all anticholinesterase agents. When a chemical threat is suspected, either from intelligence or because of an attack in adjacent areas, routine exposure of the kit samplers at periodic intervals would significantly extend the capability presently provided by the M8 Alarm to warn against low concentration chemical hazards. This supplemental early warning capability of the kits is particularly significant in view of the wide distribution planned and the operational simplicity of the kits. It must be recognized that the M8 Alarm will not always be available for all tactical situations requiring an early warning capability, due either to availability or to mobility considerations. Upgrading of the kit requirement to Priority I would make the priority consistent with that designated for automatic alarms.

c. The development approach detailed in the Advanced Development Plan offers the best approach commensurate with minimum development risk for satisfying the chemical agent detector kit requirement.

2. Termination of ED Contract

A Termination Contracting Officer has been appointed for the Westinghouse contract, DAAA15-68-C-0675, and termination proceedings are progressing. The expeditious return of the Government property accumulated under the Westinghouse contract is important to the planned advanced

development effort. The Termination Officer has authorized Westinghouse to subcontract for the shipment of the material and equipment to Edgewood Arsenal. Packaging of the equipment, including the disassembly and packaging of the clean room, has started and will require 4 to 6 weeks.

3. Testing of Detector Crayons

The technical difficulties encountered in the development of the XM235 and XM181 Kits which resulted in suspension of ED were only concerned with the nerve agent enzyme test and the mustard DB-3 test. The detector crayons for L, CG and AC/CK, used in the multipurpose kit, were manufactured at Edgewood Arsenal and were not included in the reliability testing performed at Westinghouse. In order to establish the adequacy of the detector crayons, a test program was conducted by Field Evaluation Division, Technical Support Directorate. The overall performance of the crayons was found to be satisfactory after two weeks of storage under desert, tropical and cold (below 0°F) conditions. It was noted that crayon marks could be more readily applied to 0.5 inch diameter spots than the 0.25 inch spots on the XM235/181 type samplers. The poor color change on the Lewisite test was also noted; from tan to an olive drab. The advanced development program on alternate design configurations will consider the use of larger spots for the crayon tests and the use of a reference spot for the Lewisite test to make the interpretation of a positive test easier.

Studies were conducted on back-up approaches which might be used in competitive designs for the kit. Samples of reagents microencapsulated by National Cash Register Co. were evaluated. Microencapsulated beads of DB-3 reagent in benzene had large weight losses in storage which resulted in poor sensitivity to H. The microencapsulation of copper chloride and potassium carbonate solutions did not yield a product capable of withstanding storage of 65°C. for 2 weeks. Storage tests are in progress on DB-3/toluene in microencapsulated beads.

In work designed to obtain satisfactory blisters of liquid reagents, the use of glass vials has been investigated. Sample vials from Franklin Glass Co. were filled with solutions of carbonate, copper chloride, DB-3, substrate and buffer. After sealing, the vials were stored 2 weeks at 65°C. All of the reagents held up well including the carbonate which was in a special non-corrosive glass. The other reagent vials were soda lime glass. The Plastics Lab is making a plastic sampler to hold the glass vials so that more extensive testing can be conducted.

Additional papers were made of the improved heater system which consists of aluminum granules in a paper matrix. The use of 40 mesh granules instead of 30 mesh produced a paper which was more uniform and reacted more rapidly.

E. (U) Detector Kit for Incapacitating Agents
Task 1B662710AD29-02

Priority	Proposed Schedule AD	ED	TC
I	Indeterminate.		

Litton Systems, Inc. (Contract DAAA15-69-C-0297) has emphasized the detection of incapacitants in the presence of masking interferences (screening smokes, dust, combustion products). Thin layer chromatography (TLC), sublimation, electrophoresis and electrostatic precipitation were considered. No conclusive results have been obtained. The contractor also began studies on techniques for sampling surfaces including solvent-wetted detectors and adhesive tape samplers. Litton completed work on an aerosol generator capable of delivering controlled and reproducible aerosol clouds in the submicron region. They also reported a technique for measuring the size of the particle using an oil-immersion microscope and Rhodamine-B as a tracer.

In-house tests on the aerosol spray can reagent system have demonstrated that the Freon/nitrogen propellant can withstand two week storage at 70°C and still function at 4°C.

A variety of Whatman filter papers were tested in a search for a material with better chromatographic properties than fiberglass. Extensive tests showed that all the papers were considerably less sensitive than fiberglass.

A program was established for detection of incapacitants on surfaces which includes various surface finishes (hard, soft, loose, smooth, rough), application of agent/simulant and evaluation of sampling procedures. One problem in the use of adhesive tape was identified as build up of reagent which gave a false positive indication. Dry fiberglass gave good tests when pressed on surfaces.

A major effort has been placed on detection of incapacitants in the presence of masking interferences. A large number of papers, fiberglass, silica gel sheets and combination fiberglass/silica gel sheets were screened for thin layer chromatographic separation of agent from interference. No single medium has the features of reagent compatibility, air sampling qualities and chromatographic properties. All the filters tested exhibited a strong interfering fluorescent solvent front with the reagent. This appears to be due to a physical alteration in the chromatographic medium which occurs during elution rather than a chemical interaction.

A thorough study was made of simulants for use in the detection of incapacitants and in the further development of the detector kit. Methyl benzilate (MeB) was selected since it gives a positive test with the detection reagent and has physical properties similar to BZ. An analytical method was established based on hydrolysis and oxidation

to benzophenone and measurement at 258 mμ. The simulant was disseminated as an aerosol and a relationship between simulant concentration in the chamber and concentration of the feed solution was established. The efficiency of the collection filters for the particles was determined. Litton performed a particle size analysis and reported that 90% of the particles were <0.4μ and 100% were <0.64μ. Further studies were performed to correlate the sensitivity of the reagent system to both BZ and MeB. It was found that approximately 6 times as much MeB as BZ must be collected to produce an equivalent response. This can be resolved by increasing sampling time and the concentration of feed solution when using MeB.

F. (U) Liquid Agent Detector (LAD)
Task 1B662710AD29-02

	Proposed Schedule		
Priority	AD	ED	TC
II	74	76	78

Further studies were conducted on improving the gasoline resistance and speed of response of the overcoated liquid agent detector (LAD). Two new overcoats were prepared by D.H. Litter (Contract DAAA15-69-C-0231). Aging (two weeks at 70 C) has not affected the speed of response of either one. One coating has shown no color change with any type of gasoline. The other has given a slight pink color with high test gas but is unaffected by Army gas. Several gallons of both overcoats have been made by D.H. Litter and forwarded to Litton Systems (Contract DAAA15-68-C-0708) for use on both the high speed and low speed rotogravure machines.

Litton had a specially engraved test roller made for use by Rotogravure Corporation. This roller has four different cell depths and four different lines per inch. Mylar film was coated with the detector coating and one of the new overcoats; resulting in 254 different possible combinations of coating/overcoating thicknesses. This study was to determine the effects of coating thickness on speed of response, spread factor and scuff resistance. The evaluation has not been completed but preliminary data indicate that cell depth (on the roller) of 5 and 10 mil produce a coating which is too thin for viewing a color response. Also, the number of lines per inch within the range tested has little effect on speed of response or spread factor.

Litton requested Pressure Sensitive Corporation to coat a roll of mylar with a 1.5 ml thick adhesive for studies on adhesvion to coth. The material received had a 0.5 mil coating and will be used in field tests. Additional material has been ordered.

A series of dyes related to B-1, the active ingredient in LAD, were synthesized in-house. Several had poorer gasoline solubility than B-1 and were formulated into coatings by D.H. Litter. As a result of preliminary tests on these coatings, an additional quantity of 1 (4' -amino - X' - nitro) phenylazo-2-amino-8-naphthol (identified as B-2, NH_2NO_2)was prepared and forwarded to D.H. Litter for incorporation into

a coating. The preliminary tests indicated no color from gasoline, no discoloration after two weeks storage at 70°C. The overcoated detector had a speed of response, spread factor and color equal to the best B-1 dye formulation.

Litton Systems has fabricated a device to measure film thickness and scuff resistance. Tests will be conducted to demonstrate its reliability.

Evaluation is continuing on data obtained by Litton on their field spray tests with simulants to establish the best placement of LAD on individuals. Results to date confirm earlier data which indicated that the wrists, arms and ankles were the best locations.

G. (U) Base Chemical Laboratory
Task 1B662710AD29-02

	Proposed Schedule		
Priority	AD	ED	TC
II	*	*	*

* Schedule contingent on problem definition study underway.

1. General

An informal copy of a draft proposed QMDO has been received from CDC, CBRA and joint Def Dev & Engr Labs and Rsch Labs comments were returned to the agency. The mission statement has been broadened to include surveillance testing, limited quality control of offshore procured CR material and monitoring of air, water and soil for contaminants. This provides a peace time mission for the lab. The official draft of the QMDO is expected in October 1970.

Autonetics (Contract DAAA15-70-C-0065) has expended all of the funds allocated for the laboratory test and evaluation phase of the contract. They are evaluating this data and preparing the draft of the final report of the contract. Autonetics has indicated that they will not have sufficient funds to support personnel to rewrite the draft and incorporate the editorial and/or technical corrections which will probably be recommended by Edgewood Arsenal. In addition, Autonetics has stated that the $2,500 they originally estimated and set aside for repacking of the M2A1 laboratory for shipment back to Edgewood Arsenal is in error and additional funds will be required.

An unsolicited proposal has been received from Autonetics for follow-on work to the present contract. It is being evaluated.

2. Sampling Techniques

A literature study was conducted to determine the

extent of recent developments in the field of trace gas sampling. Nothing has been found which could contribute directly to chemical agent detection. Sampling tubes made of glass, stainless steel and Teflon have been made and will be compared using various collection media to determine their ability to retain selected chemical mixtures over 24-48 hr.

Three field tests were conducted to obtain background information on atmospheric profiles. Cryogenic sampling was employed. Samples taken during the first test (300 min sampling time at 1 l/min) have been analyzed by Med Rsch Labs with a gas chromatograph and mass spectrograph. Approximately 48 compounds were reported as identified and probably present.

H. (C) Personnel Detector (Task 1B662708AD18-02)

1. (U) General

(U) In response to a request from the USAMC STANO office information was forwarded on the XM3 Personnel Detector, the modified ASR-3 Detector and the Continuous Flow Condensation Nuclei Counter. Evaluation of these detectors in Project MASSTER is under consideration.

2. (C) Condensation Nuclei Detector

(U) The two Continuous Flow Condensation Nuclei Counters (CFC) designed and constructed by Southern Research Institute (SRI) were delivered in August for the initiation of the Cambridge field tests. Initial tests showed that the instruments gradually lost sensitivity during the first half hour of operation. The problem area was isolated to the humidifier, but attempts at field fixes were unsuccessful. The instruments were returned to SRI where a humidifier of a new design was installed and tested. The gradual loss of sensitivity was found to be related to the elevated temperature of the sampled air at the inlet of the humidifier. When the sample air is heated prior to mixing with the hot water vapor in the humidifier supersaturation does not occur even though the absolute humidity of the sample air is increased. The original humidifiers were constructed so that the entire sample inlet was heated by conduction. The new humidifiers were made of thin wall stainless steel tubing and most of the heater wire was placed near the exit end of the humidifier. The wick was wound in a spiral shape and placed inside the tube so that it extended below the hot region of the humidifier. A thermistor was placed near the exit end of the humidifier and additional electronics were added to control the temperature of the humidifier. An airflow regulator was installed on the sample inlet to reduce the variation in the output that could be caused by changes in the flow rate of the sample. The CFC's were returned to Cambridge for the final two weeks of the field tests. At the conclusion of the field testing the CFC's were returned to SRI for the completion of the laboratory testing specified in the contract.

(U) The field tests for the comparative evaluation of the CFC, the modified ASR-3 Detector, the General Electric miniaturized counter and the XM3 Personnel Detector were conducted in the Cambridge, MD area during the period of 17 Aug through 18 Sep. The test area was a hardwood forest with a level canopy approximately 80 ft. above the ground. A one kilometer square test grid was marked above the treetops. Data passes were made at treetop level at distances of 200, 100, 50 and 0 meters downwind of the target with reference passes 700 meters upwind. A total of 562 of these data passes were made during the test period with approximately 88 hours of flight time. The target sources consisted of a 3 H.P. gasoline engine, a 4 lb. charcoal fire, a wood fire (approximately 15 lbs. of oak wood), and 30 cigarettes burning in a test fixture.

(U) A preliminary analysis of the test data has shown that the CFC has a greater sensitivity and faster response to all of the sources than the other types of CN detectors. In several instances the CFC made detections when none of the other detectors responded. The XM3 and the Modified ASR-3 detector showed a nearly equivalent sensitivity to the sources. When the output reading of the Modified ASR-3 Detector was zero suppressed and the gain of the detector was increased so that the noise level was equivalent to that of the XM3 and CFC the response of the ASR-3 was greater than that of the XM3 but still was not as great as the CFC. The CFC has built-in zero suppression and high gain amplification. The General Electric miniaturized counter which operates at a sampling rate of two cycles per second (as compared to five cps for the XM3 and ASR-3) was less responsive than the other detectors. This confirms tests conducted by the Land Warfare Laboratory in comparing the responses of a 10 cycle, 5 cycle and 2 cycle detector.

(U) The field tests emphasized the dependence of detection capability upon the background concentration of condensation nuclei. There were a large number of tests conducted with background over 10,000 nuclei/cc as compared to the normal background of 3,000 to 5,000 nuclei/cc found in remote areas, and this increase in background level significantly reduced the number of detections made. The General Electric miniaturized counter and the XM3 Detector operated with no electrical or mechanical malfunctions. The modified ASR-3 detectors had three electronic failures which were the first failures in over 1,000 hours of operation on the detectors. The air pump on the CFC counter is inadequate for the performance requirements and malfunctional several times during the test period.

(C) The test data confirms the results obtained on the Military Potential Tests for Personnel Detectors in that 200 meters is the practical distance limitation on detection capability for these sources, when concealed by a tree canopy. There were several detections of the cigarettes but this detection capability is considered marginal even under optimum conditions. In prior work, laboratory and field testing had shown that the original prototype CFC had a greater sensitivity to charcoal fires than to engine exhausts. A more detailed analysis of the data is required to determine the degree of selectivity offered by the new CFC's. A rigorous analysis of the data is being planned by SRI

utilizing computer programs that were established for the analysis of data from the Military Potential Tests. A small contract extension is planned for SRI to bring the CFC into optimum working condition in its present configuration and to do the data analysis.

3. (U) New Concept Studies

Liaison is being maintained with the Land Warfare Laboratory on the bioluminescent detector (RPC Corporation) for personnel detection, the mass spectrometer (Varian Associates) for both personnel and explosive detection, and the Plasma Chromatograph TM (Franklin GNO Corporation) for explosive detection. During this report period field tests were conducted by Land Warfare Laboratory on the bioluminescent detector. Edgewood Arsenal personnel were not invited and test results have not been received.

Porous polymers (Porapak and Chromosorb) are being studied to determine their collection efficiency and the efficiency of transfer of trapped compounds from the polymer to the gas chromatograph using different transfer techniques. The transfer methods being studied are flushing with helium while heating and evacuation while heating. Initial quantitative studies are being conducted with isoprene, acetone and butanol since Med Rsch Labs reported that these are always present in human effluents in higher concentrations than found in the field. A list was compiled of compounds which have been found in cryogenic and polymer sampling. Studies were conducted to determine the gas chromatographic sensitivities and recoveries of pyruvic and lactic acids.

IV. (U) Demilitarization Programs Support

A. General

EATM 300-4, Chemical Alarms and Detectors for Demilitarization, Storage and Transport Operations, has been completed and is now available to interested agencies. This document is unclassified, and summarizes alarms and kits capabilities and availabilities in a convenient reference format. It is applicable to present and future operations such as EAGLE, RED HAT, and the Portable Demil Facility.

1. Project EAGLE

GB Detection. The E49 LOPAIR installation at Rocky Mountain Arsenal has been completed, and the equipment has been operating almost continuously since late July. Several operating days were lost when the Sorenson DC power supply, a commercially-procured unit mounted in the LOPAIR control console, failed. The supply failure resulted in a voltage roughly three times normal being applied to all six operating E49 alarms and, despite individual system fusing, two alarms were damaged. The supply has been repaired, and a new identical unit procured to serve as a back-up source of power. In addition, protective circuitry is being designed to prevent alarm damage in the event of further similar power supply failures. An automatic circuit has been added to the console to provide up to three hours continuing operation from batteries in the event of power line failure. Batteries are automatically recharged when power is restored. Alarm failures to date, which are being carefully logged, involve mainly glower modules (shorting between glowers and preheater cards), synchronous motors (bearings and electronic failures), and power supply electronic cards in the alarm transceivers. The latter failures appear to be associated with one brand of synchronous motor used in the E49 alarms. Another brand (Kearfott) has not exhibited these problems to date. Accordingly, an emergency order has been sent to Kearfott to construct 15 motors from parts left over from the original LOPAIR contract. Use of these parts will save the Government $125 per motor and will cut delivery time from 90 to 60 days. These new motors will be used to retrofit existing E49 alarms. Spare, interchangeable bearings are also on order from another manufacturer. The General Electric Co. has been contacted, and engineers involved in the original E49 development program there have visited Def Dev & Engr Labs to discuss electronic failures, primarily in the power supply circuits associated with motor excitation. A small contract ($25,000. range) is envisioned to permit GE to repair existing circuit boards and insure that all circuitry is of the same configuration, since many circuit modifications were made during the last stages of the E49 development program. This has been discussed with Project EAGLE management. This repair/retrofit effort appears critical to E49 success at RMA under EAGLE, since intensive effort has been required by Def Dev & Engr Labs personnel to maintain total E49 operational capability at RMA to date. Unless spare parts are made available within the next few months, Def Dev & Engr Labs engineers and RMA maintenance personnel will be hard pressed to maintain operation of the full

RMA storage yard installation. Results obtained from operating E49 equipment in two months continuous performance to date have been impressive. Very few false alarms have been noted, and sensitivity has been at least equal to design levels. Problems at present center around maintenance time requirements, especially at RMA, and not around E49 alarm acceptance. RMA QA personnel have not been able to utilize E49's to the degree desired in checking storage plots for leakers, owing to the shortage of E49's for the storage yard.

Five M8 alarms were returned from storage for Project RED HAT in early September, including power supplies, remotes and servicing kits. These are being checked for operation prior to shipment to RMA for EAGLE use in early 1971. Two alarms, with servicing kits and batteries, were carried to RMA on 28 September 1970 by an engineer familiar with their design and operation. These will be used in training of RMA operating personnel, and will be left at that site for initial use in leak detection, etc., to permit full familiarization with their capabilities. New servicing kits have been purchased to last throughout the EAGLE program, and 200 batteries are on hand with the remaining 200 to be delivered well before the beginning of EAGLE GB operations.

The M5 alarms at RMA should be ready for EAGLE operations as scheduled. Of 17 available operating M5's at RMA, only 14 will be required for operations as now envisioned. Spare parts are readily available in RMA supply stores, and Tech Support Dir has indicated that the nine older model E59's at that site may be cannibalized for spare photometers or other parts as needed. Three E59 alarms will be made operational in time for EAGLE operations, of which two will be in continuous service with one serving as a spare. Def Dev & Engr Labs tests of optimized M5 and E59 alarms showed no major differences in their performance with both capable of response in the .02 to .03 mg/m^3 of GB range for alarm. Both will be used in EAGLE, with remote readings brought back to a central control console in the case of four alarms to be placed at critical locations where actual emission into the atmosphere is involved. A few minor sampling problems remain to be solved, but these are provided for in current scheduling. In-house work will consist of an evaluation of methods to be used in on-site (RMA) GB agent sensitivity check of the detectors and their sampling probes. The problem will involve generating low and stable concentrations ($\sim$.02 γ/l - .1 γ/l) of GB. Some methods which will be evaluated will consist of agent vapor delivery tubes containing GB in solvents, GB impregnated on porous materials (i.e., allundum chips), and possibly miniature versions of the Q5 generator. It is felt that any acceptable method may require constant temperature conditions to maintain a constant concentration of the agent generated. Agent sniff tubes were utilized at various test sites during E/ST of the M8 alarm. These will be among the initial items tested.

H Detection. Detection of H is one of the most vexing problems facing EAGLE. Def Dev & Engr Labs can offer no developmental equipment or field items other than kits capable of sensitive mustard detection. The Honeywell Ion Mobility and ITTRI DC Discharge detectors now in feasibility study in Def Dev & Engr Labs are not particularly suitable for EAGLE requirements. The Ion Mobility unit lacks adequate sensitivity for thaw room applications and is too sensitive to HCl, and probably SO_2, to be used in the stacks. The DC Discharge has excellent potential for similar applications, but is not available within the specified time frame. Accordingly, it has been Def Dev & Engr Labs' position in EAGLE to assume an advisory capacity in the selection of applicable, commercially-available alarm equipment by Cml Process Lab, Wpns Dev & Engr Labs, the organization charged with design of the EAGLE mustard demil facility. Tracor, Inc., proposed the use of chromatographic equipment using hydrogen flame detectors and time gating for alarm. In meetings involving Tracor, Def Dev & Engr Labs and Cml Process Lab personnel, the shortcomings of this equipment were discussed since Def Dev & Engr Labs has had prior experience with the hydrogen flame techniques in its HYFED programs. Four systems (two per stack to be used on a time-staggered basis) have been funded for procurement by Cml Process Lab. For thaw room use, Def Dev & Engr Labs and Cml Process Lab personnel have recommended procurement of a Technicon instrument with automatic sampling as the only item available capable of reaching specified TLV concentrations of less than .01 mg/m^3 of mustard. Kits and SOP's can be used to supplement the alarm in the actual operation.

2. Project RED HAT

There were no requirements under RED HAT during this quarter; seven M8 alarms are still being held at Edgewood Arsenal Tech Escort for that program, with five having been removed for assignment to EAGLE as discussed above.

3. Portable Demil Facility

Owing to the nature of sensitivity and portability requirements for alarms under this program, Def Dev & Engr Labs have concurred with the choice of the E59 alarm for GB detection. The E59 can be procured within the time frame of the program now envisioned. Kits can be used as required to supplement these alarms.

4. Vapor Detection Systems for Use with Stored Munitions

At the request of HQ USAMUCOM a briefing was held for Mr. J. Chamberlin, USAMC, on the problem of detecting agent vapors from leaking munitions in storage areas such as igloos. A proposed 48-month program was presented in which depot sites would be provided with automatic monitoring equipment and improved kits for GB, VX and H. Total cost of this program would be $6000K including equipment cost and igloo and site modification. Alternate 30 and 12 month programs were also presented. The briefing was followed up by a report which was sent to MUCOM.

V. (C) MISCELLANEOUS

A. (C) Nerve Agent Generation Using Binary Techniques

(C) An investigation directed to the production and generator use of gram quantities of GB, GF and VX through the binary process is being conducted. Two gram quantities of binary GB and GF have been synthesized and successfully evaluated in Q5 generators containing a slightly modified equilibrator.

(C) Comparative M8 detector tests between generator concentrations of binary GF, assayed at 52-56% purity, and Chemical Process GF (85% purity) have shown good correlations. Attempts are being made to substitute GF for GA as a physical simulant in the evaluation of the M8 detector since there is no binary method for producing GA agent.

(C) Synthesis of 10 gram quantities of VX (79-81% purity) have been performed in-house. Since a new supply of VX is needed for each day's testing, the use concept is to prepare a 10 gram quantity in advance and then use 2 gram increments on a daily testing basis. An evaluation of M8 detector response times to both binary agent and in-house agent has shown nearly identical results. Vapor interferences previously encountered with synthesized VX have been minimized through minor changes in the procedure for preparation. A stoichometric sulfur addition along with lower heat conditions of the intermediate has yielded a VX quality comparable to VX procured from Cml Process Lab.

(U) Close coordination of in-house binary procedures and generator techniques has been maintained with personnel from Quality Assurance Directorate who are preparing formal documentation for use by the M8 product contractor.

(U) Future work will include additional binary GF and GA comparative testing with the M8 detector. An evaluation of analytical methods used by Research Laboratories for determination of agent purity will be made to determine feasibility for use by contractor personnel.

B. (C) C-Agent Detector Testing with Specific Agents

1. (C) EA5414

(C) In-house studies were initiated to determine the M8 detector's capability to detect EA5414. Previous work with EA5365 which differs from 5414 by one less CH_2 group and EA5366, the quaternary salt of 5365, had shown that concentrations of EA5365 (10 mmg) dissolved in dry benzene and EA 5366 (1 mmg) dissolved in 0.05 m. Tris buffer (Ph 8.0) and deposited on an M8 filter gave little if any response in the M8 detector. The EA5366 (.05 mmg) in Tris buffer when deposited directly into an M8 cell gave, however, responses from 15-20 mv.

(C) A preliminary study of EA 5414 (200 mmg) raw agent, when deposited directly into an M8 cell, gave a comparatively low response of 37-50 mv. At a lower M8 cell solution Ph of 8.5, the responses to 200 mmg of EA5414 were from 46-65 mv. Hydrolysis rates are slower at both Ph's as compared to GB agent.

(C) EA5414 was tested for reaction with the blue band tube (DB-3 and Schoenemann tests). Using the rubber bulb from the M15/M18 type kits, a sample above the liquid agent was drawn through the tubes. No response was obtained with either type of test.

(U) Future work will be to perform a basic beaker-cell study of the M8 system's response to comparable concentrations of GB, EA5365 and EA5414 in dry dioxane.

2. (U) AC

Recently a 30 day crash program was initiated, in a cooperative effort between Prod & Maint Engr Lab and Detection & Wng Lab, to attempt a solution to the troublesome Type II tube problem. As many as 120 batches of gel were prepared and tubed in which chemicals and moisture were varied over wide limits. Drying times and conditions of impregnated gels were varied until a satisfactory initial color was obtained. Moisture content of both the gel and charcoal was varied but carefully controlled until the initial and aged gel sensitivity was within the most stringent specification requirements.

Previously, widely different results were obtained with impregnated Type II silica gels when salicylic acid was recrystallized before use. Pre-aging of sealed tubes just about 100°F. for up to two weeks was found to improve initial color of tubes so they would meet specification requirements. Sufficient reproducible batches of gel have been made and agent tested to prove we can now make Type II tubes meeting a modified "C" spec--threshold sensitivity of 32 mmg/l before and after storage. Based on information from SAO and Rsch Labs, this sensitivity is adequate but studies are continuing to determine whether the "D" spec can be met--16 mmg/l.

Commercially available detector tubes for hydrogen cyanide (AC) were obtained and are being evaluated after storage at 4°, 25° and 65° C. After a two week period, all the UNICO (Kitagawa) tubes gave good color response with exposure to 15-20 µg AC/l. The Mine Safety Appliances tubes stored at 4° and 25° C. responded well but the tubes stored at 65° C. gave poor responses. Scott (Draeger) tubes were received later and have not completed 2 week storage.

A test was conducted to see if a blue band tube containing DB3 will respond to HCN vapors when either CC_2 powder or crushed halazone tablets is used in the tube. Vapors of HCN were passed over either the CC_2 powder or halazone and then through the silica gel in the tube. No color change in the silica gel portion of the tube was noted. The Canadians have reported they can get a color change by this method.

C. (U) CAITS - M72

Results of the rough handling testing by Tech Support Dir of the new CAITS package (the 5-1/2 gal. metal can) showed that the package is suitable for transportation and rough handling provided the bolt locking ring is used in the lid of the pail, and RTV-108 is applied in the sealing groove of the lid, and allowed to cure at least one hour prior to sealing. The pail was also tested and found satisfactory as a package for the GF bottles which are available for the retrofit of CAITS if permission to ship agents is obtained.

D. (U) C-Agent Simulant Programs

The current limitations on C-agent field tests dictates that serious attention be directed toward the use of simulants in RDT&E and procurment of CW items. This need is reflected in the following excerpts of letters from MUCOM to Edgewood Arsenal:

9 Jun 70, Subj: Field Testing of Chemical Material. "It is requested that Edgewood Arsenal review its development program to assess where additional effort is required to arrive at technology that would permit wide use of simulation in lieu of live agent testing. The need for such technology should be recognized as a high priority requirement."

10 Jun 70, Subj: Substitution of Simulants for Live Agents. "It is important that we arrive at methods that will avoid the need for toxic agents at contractors' facilities." Also, "...in connection with the M8 procurement (this headquarters) had requested active investigation of the simulant approach." And, "It is requested that Edgewood Arsenal develop a firm program to meet this requirement for application to anticipated future situations."

A number of actions were initiated in response to these requests. Many of them are still in the formative stages--changing daily--and until further refined, may reflect some overlap.

Dir of Tech Spt will assume prime responsibility for a new proposed project, "Simulation Technology for Test and Evaluation of Chemical Agent Weapons and Defensive Systems." The project will make visible the extent to which simulation will be used--something which was never emphasized before even when there was occasion for simulation. Since the proposed project is still in the drafting stage, it would be inopportune at this time to give more than a qualitative description of it.

A five year study--to start in FY71--is proposed, under the direction of a committee composed of representatives from Wpns, Defense, Tech Spt and Rsch to find simulants needed for the RDT&E of CW items. The committee members have indicated their requirements with respect to simulants and the type of support their laboratories can provide. Wpns, Defense, Tech Spt and Rsch would all receive direct funding--somewhere in the order of 10, 10, 40 and 40% respectively. The importance of the binary weapons system dictates that it will receive the greatest emphasis in priority and expenditure. Thus,

in FY71, Tech Spt and Rsch will support, almost exclusively, weapons development.

In FY72 substantial support will be given in the Defense area and be carried through the remainder of the project. The priority of Defensive items would follow the approximate order of: 1) Multipurpose Kit, 2) Point Source Alarms, 3) Area Detectors, 4) ALAD, 5) LAD Detector Paper, 6) Incap Kit, 7) Protective Systems and 8) Decontaminants.

Because of the importance of the M8 Alarm a separate direct response was made to the MUCOM guidance in the form of a project using PEMA funding. A $300K project has been proposed for "Development of Test Simulants for Acceptance Testing of M8 Alarms and Associated Components." Primary funding would go to Detection & Wng Lab, but QA Dir and Prod & Maint Engr Lab will follow the project and prepare the necessary documentation. Funds are available for the study and approval by MUCOM is imminent.

Phase I of the study will establish a list of candidate simulants for GA, GB and VX through literature search, testing of insecticides or synthesis of necessary compounds. Phase II will develop acceptance testing methodology by which promising simulants may be used to evaluate the M8 Alarm and associated hardware.

In response to the MUCOM letters, QA Dir was also requested to submit a program to develop acceptance tests and standards with simulants for a variety of standard items such as test kits, masks, filters, decon kits, alarms, boots, charcoal, etc. A $200K program was submitted on 3 Aug 70 to MUCOM. Tentative approval has been received but some parts of the program may require rewriting and further justification.

It is clear that, since the simulant studies are coming from many areas, strict coordination will be necessary to avoid duplication of efforts.

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Summary of Progress during First Quarter FY71

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11 SUPPLEMENTARY NOTES Detection & Warning Systems	12 SPONSORING MILITARY ACTIVITY

13 ABSTRACT

(U) The work reported is one of a series of progress reports containing fairly detailed preliminary information on progress in the area of detection and warning systems. The report deals specifically with the research and development status of the projects cited.

14. KEYWORDS

Detection
Engineering
Defense
Development
Alarms
Kits
Electrochemical
Enzyme
Area Scanning
Contaminants
Sensitivity
Agent
Evaluation
Laser
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Demilitarization
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REPLY TO
ATTENTION OF:

21 MAR 2013

RDCB-DPC-RS

MEMORANDUM THRU Technical Director, Edgewood Chemical Biological Center (ECBC) (RDCB-D/Mr. Joseph D. Wienand), 5183 Blackhawk Road, Aberdeen Proving Ground, MD 21010-5424

FOR Office of the Chief Counsel, US Army Research, Development and Engineering Command (RDECOM)(AMSRD-CCF/Ms. Kelly Knapp), 3071 Aberdeen Boulevard, Aberdeen Proving Ground, MD 21005-5424

SUBJECT: Operations Security/Freedom of Information Act (FOIA) Review Request

1. The purpose of this memorandum is to recommend the release of information in regard to RDECOM FOIA Request, FA-13-0016.

2. The ECBC received RDECOM FOIA Request FA-13-0016 from Ms. Kelly Knapp, RDECOM FOIA Officer. The original request was categorized as an educational request from Mr. John Olin.

3. The following documents were reviewed by Subject Matter Experts from the ECBC:

a. Classification Guide For Project Deseret (C), AD-E473230, dated 7 Jun 78.

b. DoD Project No. 112, Biological and Chemical Weapons and Defense Program Status Report (C), AD-E504030, dated Dec 62.

c. DoD Project No. 112, Status Report (C), AD-E504031, dated 1 Apr 63.

d. DoD Project No. 112, Biological and Chemical Weapons Defense Program Status Report (C), AD-E504-032, dated May 63.

e. DoD Project No. 112, Biological and Chemical Weapons and Defense Program Status Report (C), AD-E504033, dated Oct 63.

f. Org Report 42, Risk/Hazard Analysis for Hypothesized Accidents/Incidents at Selected Locations Along the CONUS Shipment Route for Project Red Hat (U), 13 May – 7 Jun 70, dated 15 Jun 70.

g. Report of Visit of USAMC Technical Assistance Team to Red Hat Site (U), 13 May – 7 Jun 71.

h. Technical Memorandum, Hazard Distance Estimates for Operation Red Hat (U), dated 14 Jun 71.

i. Technical Memorandum, Summary of Progress Detection and Warning Laboratory, First Quarter FY71 (C), AD-513330, dated Dec 70.

j. Technical Memorandum, Chemical Alarms and Detectors for Demilitarization, Storage and Transport Operations (U), AD-E470877, dated Jul 70.

4. The ECBC has determined that document 3b, c, d, e, g, i and j have been deemed suitable for release, however, all documents must have the classification and/or the distribution changed through the Defense Technical Information Center prior to any release. Documents 3a, f, and h have been deemed suitable for release; however, authority for release of the information lies with the originating agencies. Document 3a and 3h are Dugway Proving Ground documents. Document 3f is a US Army Munitions Command document, which would fall under the purview of the US Army Armament Research, Development and Engineering Command.

5. The point of contact is Mr. Ronald L. Stafford, ECBC Security Specialist, (410) 436-6810 or ronald.l.stafford.civ@mail.mil.

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